GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemical power sources, PG_00037313		
Field of study	Technical Physics		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2022/2023
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	Polish
Semester of study	6	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Anna Lisowska-Oleksiak	
	Teachers	prof. dr hab. Anna Lisowska-Oleksiak Zuzanna Zarach Zuzanna Zarach	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	0.0	30

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	2.0	18.0	50

Subject objectives

The aim of the course is to acquaint students with

a) the basics of electrochemistry in relation to chemical power sources (ChPS) and

b) the basic knowledge in chemistry of materials applicable in ChPS

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W02	knows the field of electrochemistry (electrodics and ionics), knows the measurement methods of electrochemistry, knows the rules for the selection of electrode and electrolyte materials in the context of environmental protection and access to mineral resources	[SW1] Assessment of factual knowledge
K6_W01	understands the need to use electrochemical methods in energy storage and conversion in the context of global climate change and the necessary departure from the use of fossil fuels	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge
K6_U01	can obtain up-to-date information on the electrochemistry of energy storage and conversion	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	1. Electrochemistry Ionics. Charge transport in the electrolytes; aqueous electrolytes, aprotic electrolytes, gel electrolytes, polymer electrolytes, solid state electrolytes. Electrodics. The metal electrode / electrolyte interface, semiconductor/ electrolyte interface, membrane/ electrolyte interface, Nernst law. Kinetics of the electrode reaction , Butler-Volmer equation, exchange current density, overpotential, transference number. Diffusion control, Cottrel equation. Electro catalysis. New phase formation - electrocrystalization, electro-polymerization. Mechanism of chosen electrode processes: hydrogen oxidation, methanol oxidation, dioxygen reduction. Electrochemical methods: , chronovoltamperometry, chronopotentiometry, chronoamperometry.Impedance spectroscopy. II Electric energy storage and conversion devices A) Primary batteries: Zn-MnO2, Zn /AgO, metal-air batteries, lithium primary batteries, high volume (special purpose) batteries. Anode passivation - technological solution, Solid stet cathodes and liquid catohodes for Lithium primary batteries. B) Secondary batteries, lead acid batteries, NiMH batteries lithium batteries, lithium -ion batteries, lithium polymer electrolyte batteries. Intercalation process, insertion into sp2 carbonaceous materials, electro-active polymers, etc. Redox flow cells Batteries recycling EU ROSH directive. C) Electrochemical capacitors a) EDLC capacitors, b) super-capacitors pseudo-faradaic capacity c) hybrid electrodes systems . Electrode and electrolyte materials, electron collectors for aqueous and non-aqueous electrolytes. D) Fuel cells - microbial fuel cells and bio-fuel cells, (SOFC, MCFC, PMFC, DMFC - catalyst for oxygen reduction in PMFC. Methanol oxidation, Hydrogen from water splitting. E) Additional subject : Photoelectrochemical water splitting (PEC -photoelectrochemical cell) - basic rules for selection of efficient electrode materials.
Prerequisites and co-requisites	basic knowledge in chemistry

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
laboratory	100.0%	40.0%
lecture	60.0%	60.0%

Recommended reading

Basic literature	1.A. Kisza, Elektrodyka, WNT 2000 2. A. Kisza, Jonika , WNT 2000 3. A. Czerwinski, Ogniwa Baterie, Warszawa 2005 4. C.A.Vincent, B. Scrosati, Modern Batteries , New York, 1997 5. Ed. P.J. Gellings, H.J.M.Bouwmeester The CRS Hanbook of Solid State Electrochemistry, 1996 6. Instrukcje do ćwiczeń laboratoryjnych 7. Materiały do wykładu ppt (pdf)
Supplementary literature	Aktualne doniesienia z czasopism JRC
eResources addresses	Uzupełniające Adresy na platformie eNauczanie: Chemiczne Źródła Prądu 2023 - Moodle ID: 28990 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=28990

Example issues/ example questions/ tasks being completed	1. determination of overpotential in respect to hydrogen evolution on various electrodes, 2. Synthesis and characterization of electroactive polymer . 3.Prussian Blue analoques as electrodes for supecapacitors. 4. Titania as photoanode material - phtocurrent determination for ITO/TiO2, ITO/TiO2/BP 5.Gelium type electrolytes - conductivity measurements. 6. determination of chemical diffusion coefficient from cyclic voltammetry
Work placement	Not applicable